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An Option-Based Analysis of Air Transportation Infrastructure Investments

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Motivation

- **Air transportation is a key strategic asset for economic growth**
- **Given finite resources and needs in other sectors (health, education, environment, etc), decision-makers need answers to two basic questions:**
  1. How much infrastructure is needed?
  2. When is this infrastructure needed?
- **The answer is difficult because of uncertainty in:**
  - → Markets
  - → Technology
  - → Politics

Example: Size of new airport

- Demand today requires 1 runway
- Demand tomorrow may require 2 runways

Strategy: Conservative

Today: Build 1st runway

Tomorrow: Build 2nd runway

Example: Size of new airport

- Demand today requires 1 runway
- Demand tomorrow may require 2 runways

Strategy:	Conservative	Optimistic
Today:	Build 1st runway	Build 2 runways
Tomorrow:	Build 2nd runway	



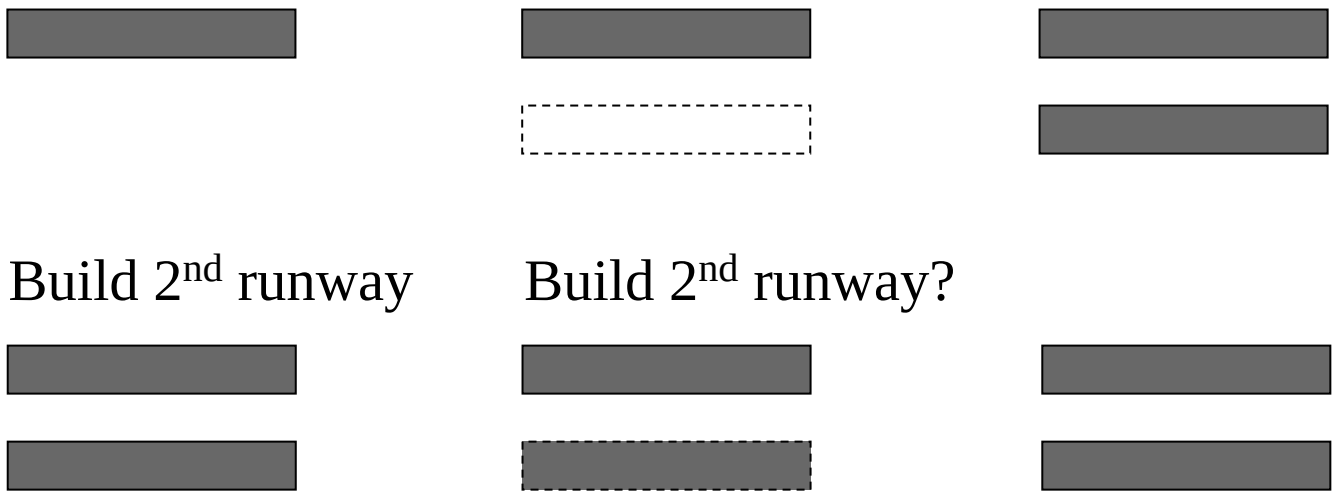




Example: Size of new airport

- Demand today requires 1 runway
- Demand tomorrow may require 2 runways

Strategy:	Conservative	Flexible	Optimistic
Today:	Build 1st runway	Build 1st runway, purchase land	Build 2 runways
Tomorrow:	Build 2nd runway	Build 2nd runway?	



Objective

- **Develop a two-part methodology to support investment decisions in air transportation infrastructure:**
  1. Evaluate the strategic value of infrastructure with financial and real options theory and Monte Carlo simulation in a system dynamics framework
  2. Determine the value of individual projects relative to other investments based on financial portfolio theory

Determining the strategic value

- **Infrastructure provide the option (i.e. the possibility but not the obligation) to:**
  - Respond quickly to changes in the market
  - Explore new markets
  - Influence markets

} **Strategic value**

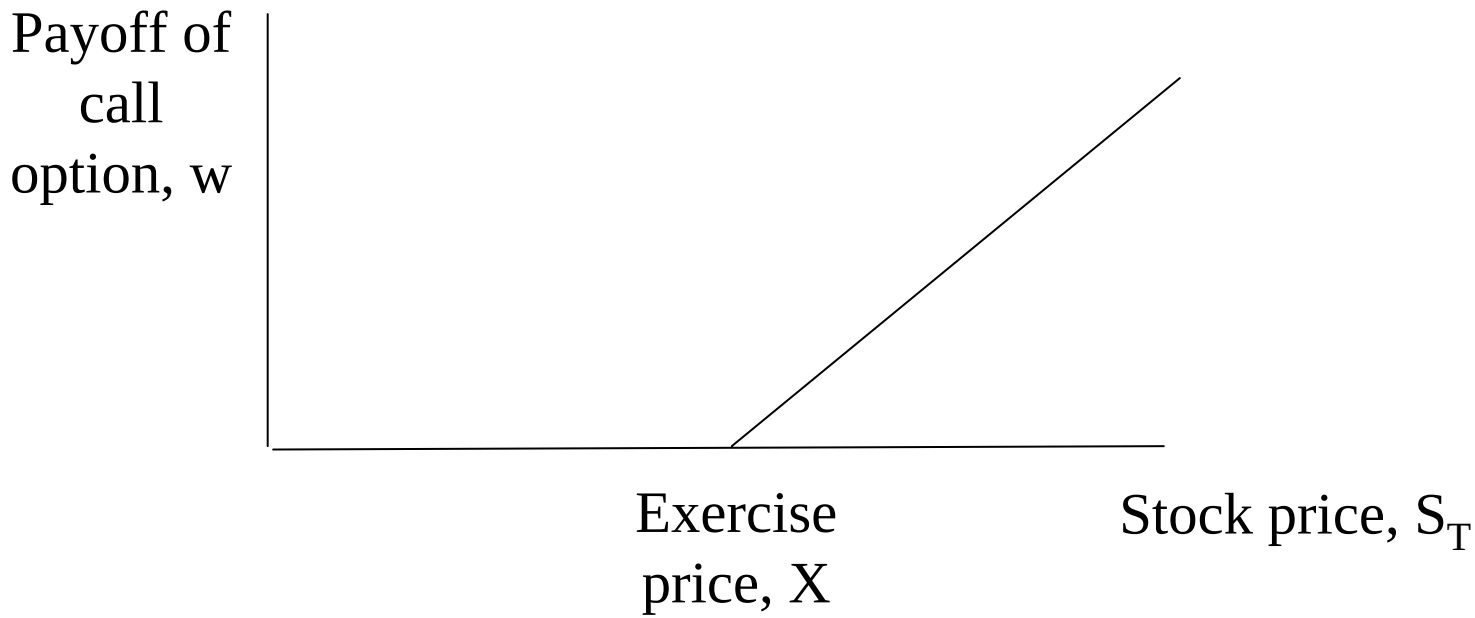
Determining the strategic value

- **Infrastructure provide the option (i.e. the possibility but not the obligation) to:**
  - Respond quickly to changes in the market
  - Explore new markets
  - Influence markets

  } **Strategic value**

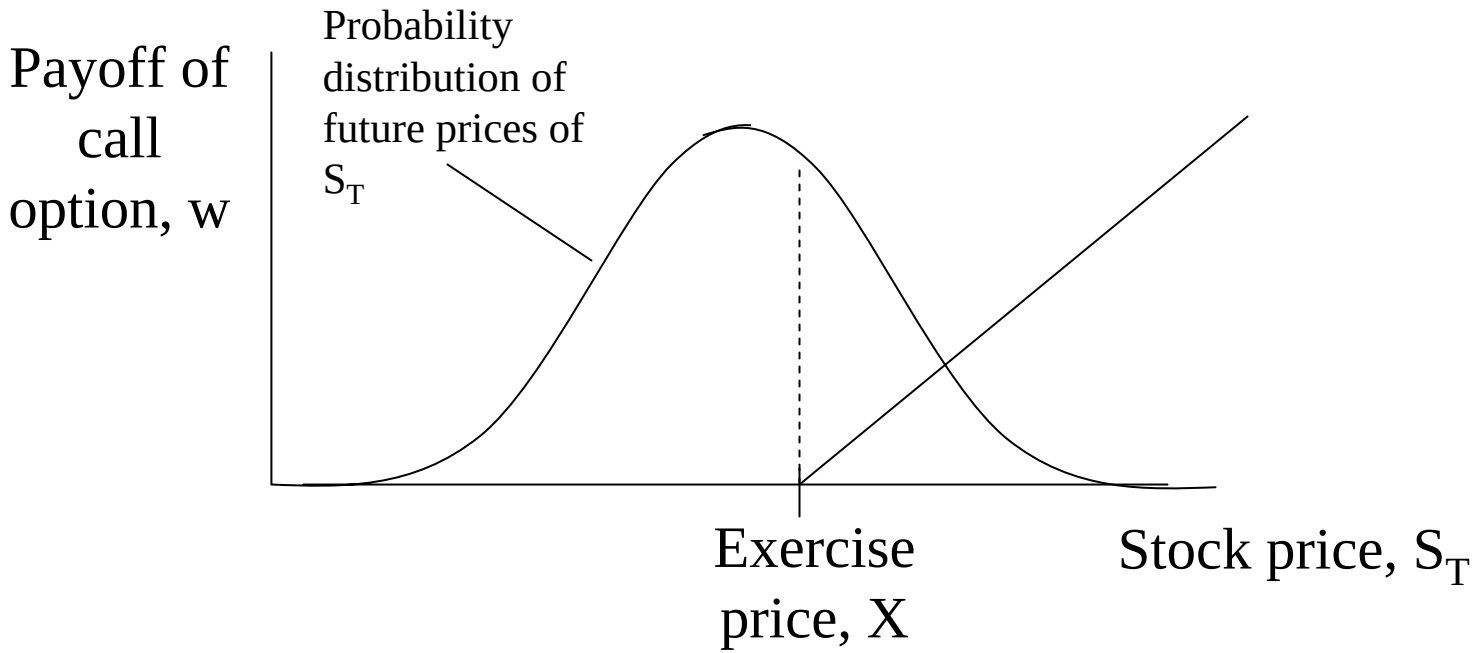
- **A real option is:**
  - the right, but not the obligation,
  - to take an action on a real project (expand, switch, abandon, etc)
  - now or in the future . . .
  - at a price.
- **In the face of uncertainty, real options allow decision-makers to profit from upside potential while limiting downside losses**
- **Real options are based on financial options theory**

Payoff of a European call option



Source: Brealey and Myers, 1996

Payoff of a European call option

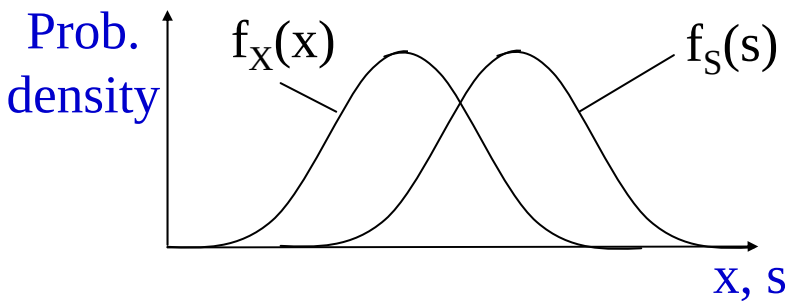


Value of option = E [Payoff | option exercised] – X * P(option exercised)

Value of option = E [S | S > X] – X * P(S > X)

Valuation of Real Options

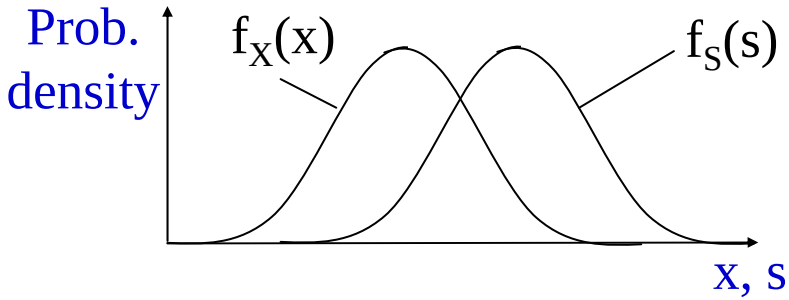
– Assume strike price not fixed a priori



$$Value_{RO} = e^{-rT}\left(\underbrace{\int_{s=x}^{\infty} s \cdot f_s(s)ds}_{E[S \mid S > X]} - \underbrace{x \cdot \int_{s=x}^{\infty} f_s(s)ds}_{X * P(S > X)}\right)$$

Valuation of Real Options

– Assume strike price not fixed a priori

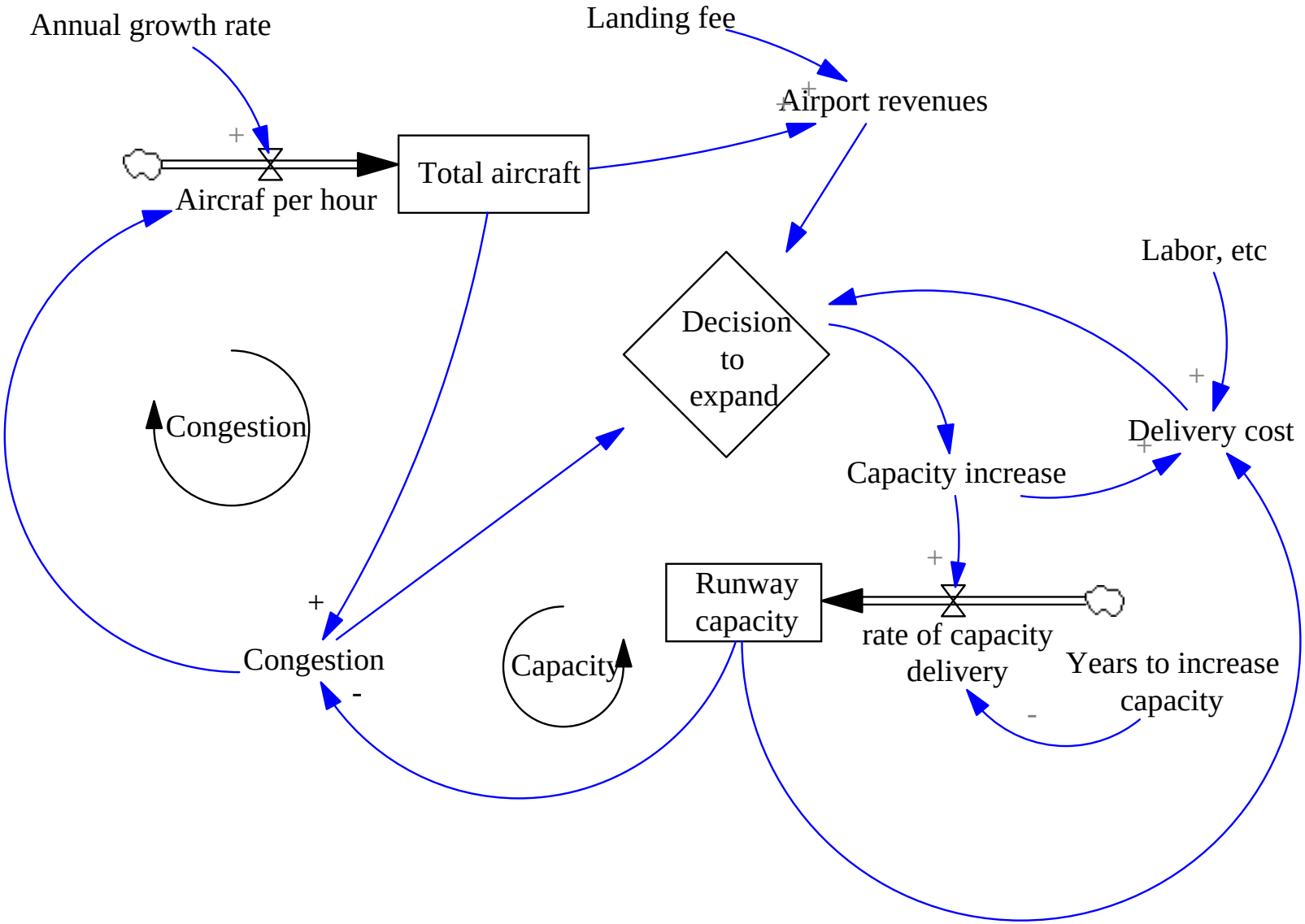


$$Value_{RO} = e^{-rT}\left(\underbrace{\int_{s=x}^{\infty} s \cdot f_s(s)ds}_{E[\,S \mid S > X\,]} - \underbrace{x \cdot \int_{s=x}^{\infty} f_s(s)ds}_{X * P(\,S > X\,)} \right)$$

$$E[Value_{RO}] = \int_{x=-\infty}^{x=\infty} C_{ROA}(x) \cdot f_X(x)dx =$$

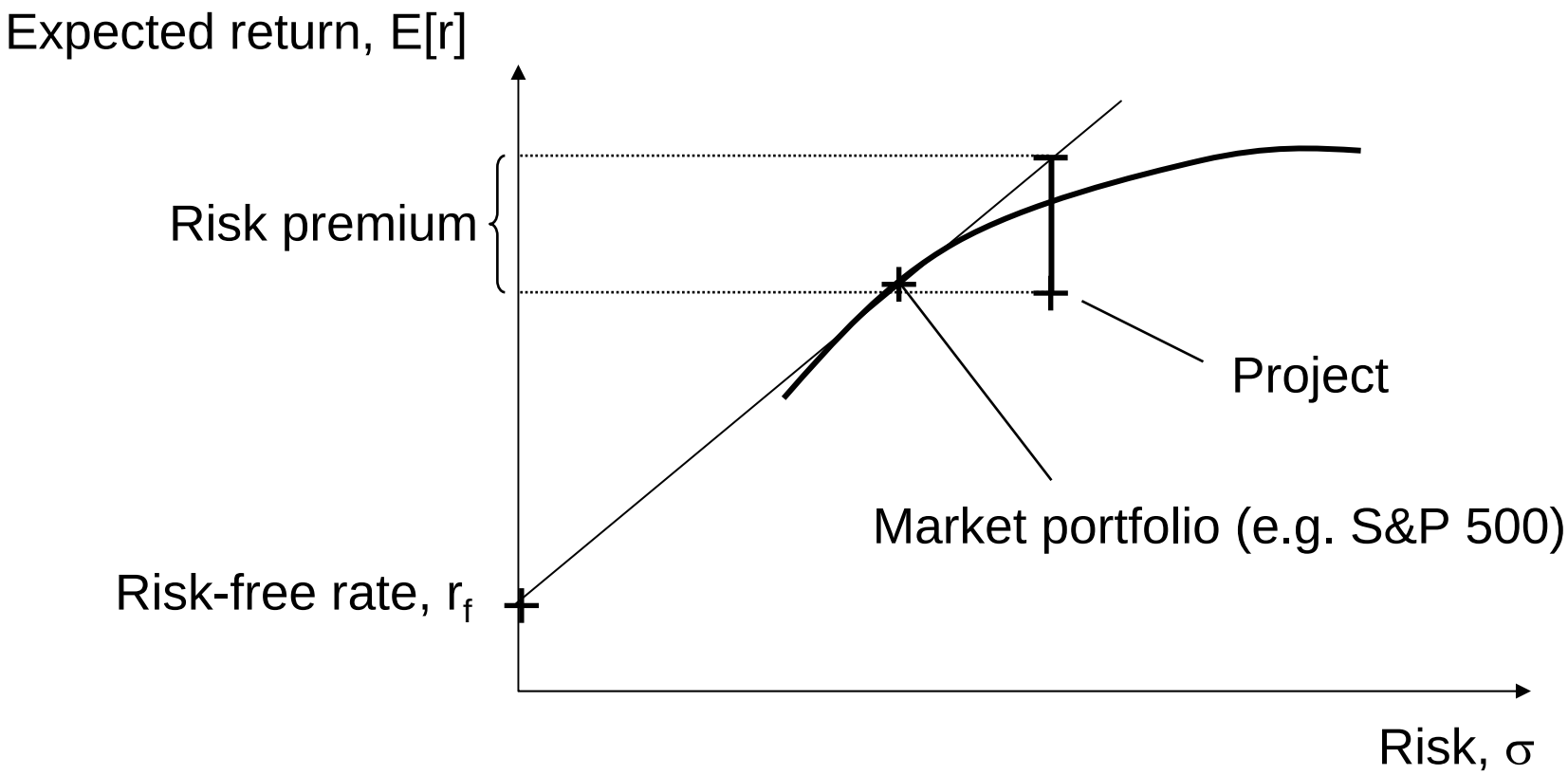
$$= e^{-rT}\left(\int_{x=0}^{\infty} f_X(x) \int_{s=x}^{\infty} s \cdot f_S(s)dsdx - \int_{x=0}^{\infty} x \cdot f_X(x) \cdot \int_{s=x}^{\infty} f_S(s)dsdx \right)$$

System Dynamics model



Discount rate

Discount rate = Risk-free rate + Risk premium



Conclusion

- **Investments decisions should include the strategic value of infrastructure for a better representation of project value**
- **The options-based methodology presented here:**
  - captures the strategic value of infrastructure
  - takes into account multiple sources of uncertainty
  - finds the appropriate discount rate for the risk of the project

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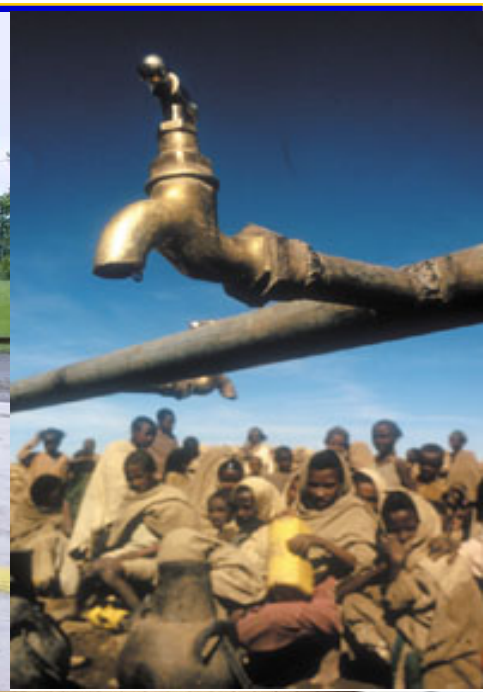
Thank you.



Thank you.

System Dynamics model